

METHODS FOR MAKING CONTROLLED-RELEASE AMMONIUM PHOSPHATE FERTILIZER

3 BACKGROUND OF THE INVENTION

4 1. Field of the Invention

5 The present invention relates to methods for making ammonium
6 phosphate fertilizer, and more particularly to methods for making controlled-
7 release ammonium phosphate fertilizer that releases nutrient continuously
8 and efficiently to the soil.

9 2. Description of Related Arts

10 Ammonium phosphate is a main compound fertilizer containing
11 nitrogen and phosphorus, two basal nutrients for plants, and takes a 58%
12 marketing proportion of all phosphate fertilizers in the world. Ammonium
13 phosphate is used as a base fertilizer or an additional fertilizer, and more
14 likely to be used as a main component of a bulk blend fertilizer or compound
15 fertilizer since the ammonium phosphate has excellent compatibility to
16 match in harmony with other different fertilizers. Ammonium phosphate and
17 other phosphate fertilizers such as superphosphate, triple superphosphate,
18 nitrophosphate, and calcium magnesium phosphate have a fatal drawback in
19 that most of the phosphate is easily fixed in soil and become too slow-
20 released or unavailabale. Therefore, the phosphorous fertilizers are not
21 efficient for a long period of time and are not completely absorbed by plants
22 resulting in low use efficiency of the phosphorous fertilizers as 15-20% in
23 the growth season of plants

24 The present invention has arisen to mitigate or obviate the

1 disadvantages of the conventional phosphate fertilizers.

2 **SUMMARY OF THE INVENTION**

3 A first objective of the present invention is to provide methods for
4 making controlled-release ammonium phosphate fertilizer that has an
5 excellent use efficiency and low producing cost.

6 A second objective of the present invention is to provide methods for
7 making ammonium phosphate fertilizer that uses agricultural waste as
8 release-controlling materials to reduce product cost of the ammonium
9 phosphate fertilizer and to enhance the use efficiency.

10 A third objective of the present invention is to provide methods for
11 making ammonium phosphate fertilizer that does not need additional new
12 manufacturing equipment whereby the fertilizer is prepared economically.

13 Further benefits and advantages of the present invention will become
14 apparent after a careful reading of the detailed description.

15 **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

16 Methods for making controlled-release ammonium phosphate
17 fertilizer in accordance with the present invention comprises the following
18 acts of: cracking, pulverizing, blending, aging, drying, and adding release-
19 controlling materials into ammonium phosphate slurry during making
20 processes or adding release-controlling materials in dried ammonium
21 phosphate product.

22 The detailed description of the method is illustrated as following:

23 (A) Adding cracked release-controlling materials into ammonium
24 phosphate slurry before condensing the ammonium phosphate slurry in

1 proportion of 3~35%(w/w, based on a dry weight of the ammonium
2 phosphate slurry);
3 mixing evenly the ammonium phosphate slurry and the release-
4 controlling materials into a mixture;
5 condensing the mixture of the ammonium phosphate slurry and the
6 release-controlling materials until a water-content rate of the mixture
7 decreases to 25~35%; and
8 granulating the condensed mixture of ammonium phosphate slurry
9 and the release-controlling materials to obtain granular ammonium
10 phosphate fertilizer, wherein granulating methods are selected from
11 following methods comprising: slurry granulating, spray granulating, or
12 fluidization granulating.

13 (B) Adding cracked release-controlling materials into ammonium
14 phosphate slurry before condensing the ammonium phosphate slurry in
15 proportion of 3~35% (w/w, based on the dry weight of the ammonium
16 phosphate slurry);
17 mixing evenly the ammonium phosphate slurry and the release-
18 controlling materials into a mixture;
19 adding sulfuric acid into the mixture for acidification in proportion
20 of 1-20% (w/w, based on the dry weight of the ammonium phosphate slurry);
21 condensing the acidified mixture of the ammonium phosphate slurry
22 and the release-controlling materials until a water-content rate of the mixture
23 decreases to 25~35%; and
24 granulating the condensed mixture of ammonium phosphate slurry

1 and the release-controlling materials to obtain granular ammonium
2 phosphate fertilizer, wherein granulating methods are selected from the
3 following methods comprising: slurry granulating, spray granulating, or
4 fluidization granulating.

5 (C) Adding cracked release-controlling material and water into the
6 dried ammonium phosphate powder, wherein the cracked release-controlling
7 material is in the proportion of 3~35% (w/w, based on a dry weight of the
8 ammonium phosphate powder) and the water is in the proportion of 3~40%
9 (w/w, based on the dry weight of the ammonium phosphate powder);

10 mixing evenly the ammonium phosphate powder, the release-
11 controlling material and water into a mixture;

12 thoroughly grinding the mixture;

13 activating components in the mixture by stacking; and

14 drying the activated mixture to achieve the controlled-release
15 ammonium phosphate fertilizer.

16 (D) Adding cracked release-controlling material and water into the
17 dried ammonium phosphate powder, wherein the cracked release-controlling
18 material is in the proportion of 3~35% (w/w, based on the dry weight of the
19 ammonium phosphate powder) and the water is in the proportion of 3~40%
20 (w/w, based on the dry weight of the ammonium phosphate powder);

21 mixing evenly the ammonium phosphate powder, the release-
22 controlling material and water into a mixture;

23 thoroughly grinding the mixture;

24 adding sulfuric acid into the mixture to acidify the mixture in the

1 proportion of 1-20% (w/w, based on the dry weight of the ammonium
2 phosphate powder);
3 activating the mixture to mature in an activating chamber to become
4 a flesh fertilizer; and
5 drying the flesh fertilizer to achieve the controlled-release
6 ammonium phosphate fertilizer.

7 The release-controlling material is selected from at least one of the
8 group comprising: zeolite, montmorillonite, pillared montmorillonite, and
9 lignin comprising alkali lignin and lignosulfonate or lignosulphonate. The
10 release-controlling material used in methods (C) and (D) having acidifying
11 acts is selected from at least one of the group comprising: acidified zeolite,
12 acidified montmorillonite, acidified pillared montmorillonite, acidified lignin
13 comprising acidified alkali lignin and acidified lignosulfonate or
14 lignosulphonate. The release-controlling material is pulverized to particles of
15 0.2-0.04 mm mesh.

16 One or more release controlling materials mentioned above can be
17 added in the processes of manufacturing ammonium phosphate fertilizer, the
18 total amount of release-controlling materials still take 3-35% weight
19 percentage based on the dry weight of the ammonium phosphate .

20 Species of the release-controlling material such as zeolite,
21 montmorillonite smectite, pillared montmorillonite, acidification zeolite,
22 acidification montmorillonite, acidification pillared montmorillonite, are
23 inorganic and have excellent ion exchanging capability to cause chemical
24 bonding with the NH_4^+ and H_2PO_4^- in the ammonium phosphate and to cause

1 complexing with H_2PO_4^- .
2 Species of the release-controlling material such as lignin and
3 acidification lignin are organic and have complex three-dimensional netting
4 structures and multiple functional groups such as hydroxyl, carboxyl, and
5 amine. These functional groups of the organic release-controlling materials
6 cause chemical bonding with NH_4^+ and H_2PO_4^- group of the ammonium
7 phosphate and also cause complexing with H_2PO_4^- . The physi-chemical
8 interactions between the release-controlling materials and the ammonium
9 phosphate reduce the crystallinity of the ammonium phosphate to enhance
10 the capabilities of anti-fixation and anti-leaching so as to result in long
11 lasting fertilization effect and higher nutrient use efficiency.

12 Since the release-controlling material combines with the ammonium
13 phosphate by chemical bonding and complexing, nitrogen and phosphorus
14 nutrients are slowly released corresponding to the plants absorption for
15 whole growth season. Thus, the nitrogen and phosphorus nutrients are not
16 wasted in soil fixation and the use efficiency increases.

17 The following examples are embodiments in accordance with the
18 present invention. Examples 1 to 4 are to add release-controlling material
19 during manufacturing process of ammonium phosphate slurry and examples
20 5-8 are to add release-controlling material into dried ammonium phosphate
21 powder.

22 Example 1:
23 100 tons of ammonium phosphate slurry with 55~65% water-content
24 rate is mixed with 4.5~3.5 tons of 0.16 mm mesh zeolite (or

1 montmorillonite or pillared montmorillonite or lignin) in an evaporator.
2 The mixture of the ammonium phosphate slurry and the zeolite is stirred
3 evenly and then condensed to reduce the water-content rate until it reaches
4 25~35%. Lastly, the condensed mixture is dried to make controlled-release
5 ammonium phosphate in forms of powder and particles by slurry granulating,
6 spray granulating, or fluidization granulating.

7 Example 2:

8 100 tons of ammonium phosphate slurry with 55~65% water-content
9 rate is mixed with 3.6~2.8 tons of 0.16mm mesh acidified zeolite (or
10 acidified montmorillonite or acidified pillared montmorillonite or acidified
11 lignin) in an evaporator. The mixture of the ammonium phosphate slurry and
12 the acidified zeolite is stirred evenly and then condensed to reduce the water-
13 content rate until it reaches 25~35%. Lastly, the condensed mixture is dried
14 to make controlled-release ammonium phosphate in forms of powder and
15 particles by slurry granulating, spray granulating, or fluidization granulating.

16 Example 3:

17 100 tons of ammonium phosphate slurry with 55~65% water-content
18 rate is mixed with 2.8~3.6 tons of 0.16mm mesh acidified zeolite (or
19 acidified montmorillonite or acidified pillared montmorillonite or acidified
20 lignin) and 2.1~2.7 tons of sulfuric acid in an evaporator. The mixture of the
21 ammonium phosphate slurry, the acidified zeolite and sulfuric acid is stirred
22 evenly and then condensed to reduce the water content rate until it reaches
23 25~35%. Lastly, the condensed mixture is dried to make controlled-release
24 ammonium phosphate in forms of powder and particles by slurry granulating,

1 spray granulating, or fluidization granulating.

2 Example 4:

3 100 tons of ammonium phosphate slurry with 55~65% water-content
4 rate is mixed with 2.8~3.6 tons of 0.16mm mesh zeolite (or montmorillonite
5 or pillared montmorillonite or lignin) and 2.1~2.7 tons of sulfuric acid in an
6 evaporator. The mixture of the ammonium phosphate slurry, the zeolite and
7 sulfuric acid is stirred evenly and then condensed to reduce the water-content
8 rate until it reaches 25~35%. Lastly, the condensed mixture is dried and
9 granulated to make controlled-release ammonium phosphate in forms of
10 powder and particles by slurry granulating, spray granulating, or fluidization
11 granulating.

12

13 Example 5:

14 100 tons of smashed ammonium phosphate powder is mixed with 10
15 tons of 0.16mm mesh zeolite (or montmorillonite or pillared montmorillonite
16 or lignin) and 8 tons of water. The mixture of the smashed ammonium
17 phosphate, the zeolite and water is thoroughly stirred and ground evenly and
18 then the mixture is piled for 1~3 days for activation. Lastly, the activated
19 mixture is dried to make controlled-release ammonium phosphate particles.

20 Example 6:

21 100 tons of smashed ammonium phosphate powder is mixed with 10
22 tons of 0.16mm mesh acidified zeolite (or acidified montmorillonite or
23 acidified pillared montmorillonite or acidified lignin) and 8 tons of water.
24 The mixture of the smashed ammonium phosphate, the acidified zeolite and

1 water is thoroughly stirred and ground evenly and then the mixture is piled
2 for 1~3 days for activation. Lastly, the activated mixture is dried to make
3 controlled-release ammonium phosphate particles.

4 Example 7:

5 100 tons of smashed ammonium phosphate powder is mixed with 8
6 tons of 0.16mm mesh zeolite (or montmorillonite or pillared montmorillonite
7 or lignin) and 8 tons of water. The mixture of the smashed ammonium
8 phosphate, the zeolite and water is thoroughly stirred and ground evenly. 5
9 tons of sulfuric acid is added into the mixture to acidify the mixture in a
10 mixer. Then the acidified mixture is activated in an activating chamber and
11 matured to become flesh fertilizer. Lastly, the flesh fertilizer is dried into the
12 controlled-release ammonium phosphate product.

13 Example 8:

14 100 tons of smashed ammonium phosphate powder is mixed with 4
15 tons of zeolite, 3 tons of 0.16mm mesh lignin and 8 tons of water. The
16 mixture of the smashed ammonium phosphate, the zeolite, lignin and water
17 is thoroughly stirred and ground evenly. 5 tons sulfuric acid is added into the
18 mixture to acidify the mixture in a mixer. Then, the acidified mixture is
19 activated in the activating chamber and matured to become flesh fertilizer.
20 Lastly, the flesh fertilizer is dried into the controlled-release ammonium
21 phosphate product.

22 Product analysis:

23 1. Structure analysis: X-ray diffraction is used to verify the structure
24 of the controlled-release ammonium phosphate. In comparison with the

1 conventional ammonium phosphate fertilizer, the controlled-release
2 ammonium phosphate fertilizer has lower crystallization. Infrared spectrum
3 is used to check chemical bonding and finds that featuring peaks of NH_4^+ and
4 H_2PO_4^- decay and have variations of generating new diffracting peaks at
5 0.3292 nm and 0.3366nm.

6 2. Anti-fixing capability in soil:

7 0.5g of controlled-release ammonium phosphate fertilizer is applied
8 to 400g of soil and water is added to the soil to keep the soil damp. The
9 fertilized soil is cultured for 2~5 days and then shacked in 800mL of water
10 for 6 hours. Suspension of the fertilized soil is filtered and the solution is
11 tested to qualify phosphorus content. The filtered soil is tested to qualify
12 available phosphorus content and water-dissolvable phosphorus content in
13 the fertilized soil. Conventional ammonium phosphate is treated in the same
14 way to be a comparison test. In result, the phosphorus content of the filtered
15 liquid and available phosphorus content and water-dissolvable phosphorus
16 content in the soil of the controlled-release ammonium phosphate fertilizer
17 are higher than ones of the conventional ammonium phosphate fertilizer.

18 Conclusion:

19 The controlled-release ammonium phosphate fertilizer was applied
20 to a maize laterite field in equal weight with the conventional ammonium
21 phosphate fertilizer. Maize crops using the controlled-release ammonium
22 phosphate fertilizer had an additional 10~35 % of yield more than one using
23 the conventional ammonium phosphate fertilizer, thus the present use
24 efficiency for the growth season of the nitrogen and phosphorus nutrients

1 increased relative to previous fertilizers.

2 The controlled-release ammonium phosphate fertilizer was also
3 applied to pot plants in equal weight with the conventional ammonium
4 phosphate fertilizer. This experiment showed the use efficiency of
5 phosphorus has been raised an additional 5~35% and the use efficiency of
6 nitrogen has been raised an additional 5~38 %. In the structure analysis, the
7 controlled-release ammonium phosphate fertilizer had lower degree of
8 crystallization than the conventional ammonium phosphate fertilizer that
9 directly reflects the increase of use efficiency. Infrared spectrum analysis
10 indicates that the release-controlling material is combined with the NH₄⁺ and
11 H_nPO₄ groups of the ammonium phosphate by strong chemical bonding and
12 causes covalent bonding to enhance the anti-leaching capability and prolong
13 the releasing period.

14 According to the above description, several advantages of the present
15 invention are obtained:

16 1. All release-controlling materials used in the present invention are
17 agricultural waste and useless before, but in the present invention enhance
18 the use efficiency and also to reduce the product cost of the controlled-
19 release ammonium phosphate. Thus, this invention provides a new way for
20 conversion of the industrial and agricultural waste into resources.

21 2. The controlled-release ammonium phosphate fertilizer has
22 excellent anti-fixing capability to increase use efficiency and further increase
23 crop yields. Additionally, the controlled-release ammonium phosphate
24 fertilizer also has excellent anti-leaching capability to avoid water

1 eutrophication and thus is environmentally friendly.

2 3. No extra equipment is needed for producing the controlled-release
3 ammonium phosphate fertilizer, thus existing apparatus can be used to
4 produce the controlled-release ammonium phosphate fertilizer and thereby to
5 reduce both of equipment cost and operation cost.

6 Although the invention has been explained in relation to its preferred
7 embodiment, many other possible modifications and variations can be made
8 without departing from the spirit and scope of the invention as hereinafter
9 claimed.